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*Publication date:*
2019

*Document Version*
Publisher's PDF, also known as Version of record



*Citation (APA):*
Hantzi, K., Toft, A., Rankka, W., Bergstedt, E., Arnerdal, K., & Fjordbøge, A. S. (2019). *Development of a sustainable soil mixing technique using energy efficient binders and iron based reductive dechlorination*. Abstract from Sustainable Use and Management of Soil, Sediment and Water Resources 15th International Conference, Antwerp, Belgium.

**Development of a sustainable soil mixing technique using energy efficient binders and iron based reductive dechlorination**

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*Background*

Soil mixing is a delivery technique for reactants in connection with in-situ remediation of contaminant sources e.g. remediation of chlorinated organic solvents by addition of zero valent iron (ZVI). However, in this connection the mixed soil strength is reduced due to amendment with a bentonite slurry. Possible site use alternatives after treatment are therefore limited. In 2017, an innovation project called "Sustainable Soil Mixing" was launched, in a collaboration between the Capital Region of Denmark, the Swedish Geotechnical Institute and the Geological Survey of Sweden. The project is co-funded by Interreg Öresund-Kattegat-Skagerrak (2017-2020). The scope of the project is to further develop the soil mixing technique regarding chlorinated solvents, improving the geotechnical and energy efficiency performance and to demonstrate the new functions in-situ. This is done in:

a) a laboratory phase, where the project builds new knowledge on how different binder combinations affect the chemical degradation efficiency of TCE in clay till and glacial clay and the development of strength in the treated soil
b) a pilot phase, where the improved technique is tested on two field sites.

The final aim is to produce a technical guideline for stakeholders (consultants, problem owners, authorities) and to facilitate acceptance and implementation of the technique in Sweden and Denmark, thereby making it a "go to technique", equivalent to excavation and thermal remediation.

*Aim*

We will present results from the laboratory phase, which is designed to find an optimal combination of binder components (i.e. cement, slag and/or lime) and reactant(s) (Fe(II)-salts). The combinations are tested for chemical degradation and development of strength. We aim to present binder recipes. We will address several experimental challenges and the laboratory methods developed to resolve these. Some challenges are related to expected binder-contaminant interactions: chemical degradation of TCE with ZVI has previously been seen to be inhibited by high pH (>9). Cement is commonly used to improve the soil strength, but the addition of cement raises pH to >11. If ZVI is substituted with Fe(II), the high pH is beneficial for degradation, but perhaps the overall TCE degradation efficiency of the Fe(II)-cement system is reduced compared to the ZVI-bentonite system. The combination of binder components will affect the energy efficiency of the technique, which is a point for consideration, when soil mixing is seen competing with the current state of the art remediation techniques.

*Conclusion*

We expect the laboratory phase to support conclusions related to the following questions:

1) is it possible to combine binder components and Fe-additives to reach acceptable strength in soil and chemical degradation of TCE?
2) which binder combinations should be used and how can they be optimized to increase the energy efficiency?
3) how can geotechnical and environmental laboratory methods be used to support optimization in preplanning phases?
4) how does recommendations for optimization differ between different soil types?

We also expect to gain experience regarding transregional collaborations.